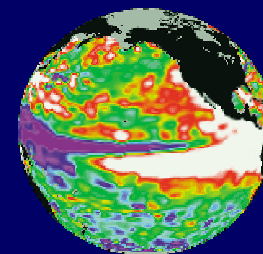




# ***Space-based Remote Sensing Program Update***

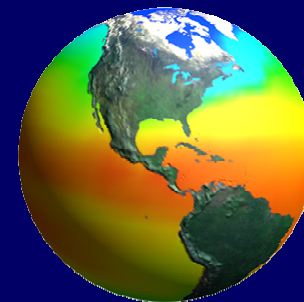
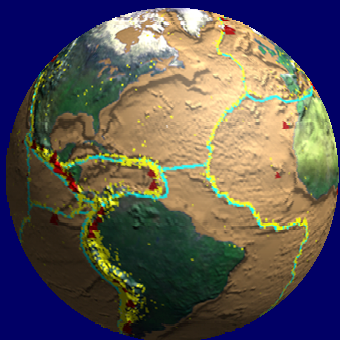


## **U.S./Mexico Red Tide Program Collaboration Workshop**



Marco J. Giardino, Ph.D.  
*Chief, NASA Earth Science  
Applications, Integration Division*

June 10, 2003





## **The NASA Vision**

To improve life here,  
To extend life to there,  
To find life beyond.

## **The NASA Mission**

To understand and protect our home planet,  
To explore the universe and search for life,  
To inspire the next generation of explorers  
... as only NASA can.



# Computing & Modeling at ESE: From Observations to Predictions

- Challenge: Integrate massive amounts of data with computationally demanding scientific models and produce products for research and decision support
- Integrate satellite data with computational modeling capabilities:
  - **Model initialization** - for weather and climate forecasts
  - **Model evaluation** - for all classes of models
  - **Data assimilation** - preparation of accurate, global, geophysically consistent data sets for research and applications uses

High-end computing and modeling are the key to transforming data into useful information for decision makers.

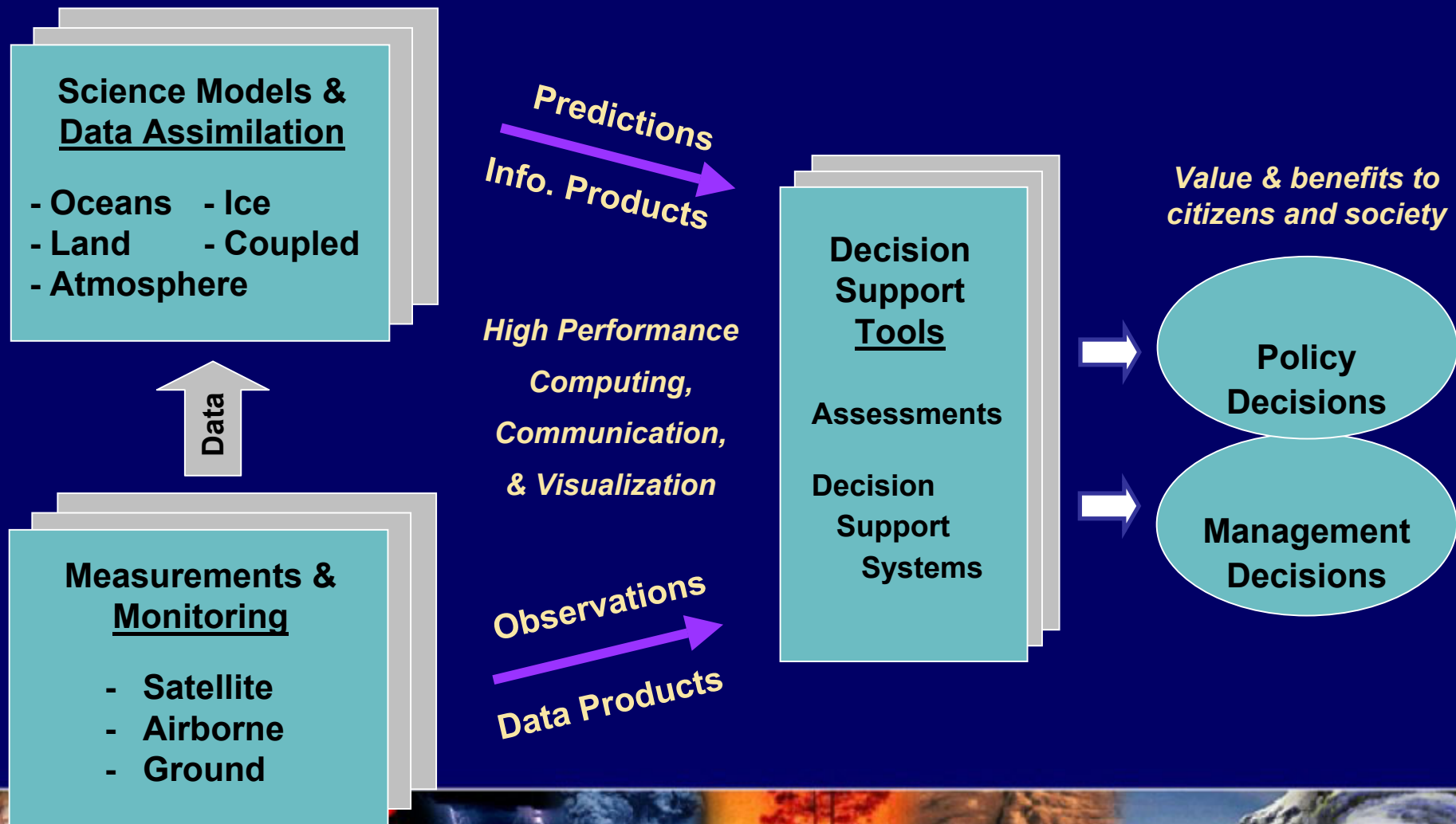






# From Science to Decision Support

*Applying NASA's system engineering approach and ESE results to support decision-making tools, predictions, and analysis for policy and management decisions.*

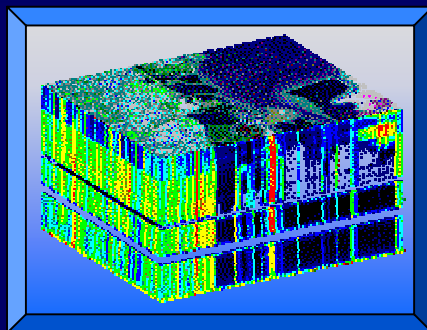




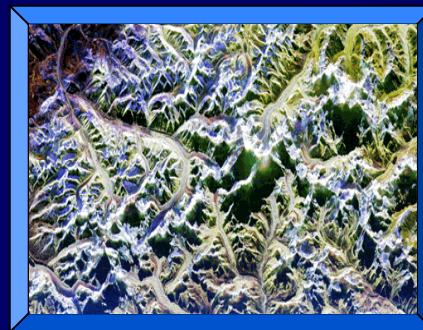
# Multiple Remote Sensing Approaches



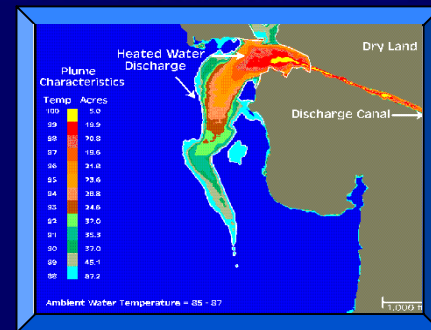
**Multispectral**



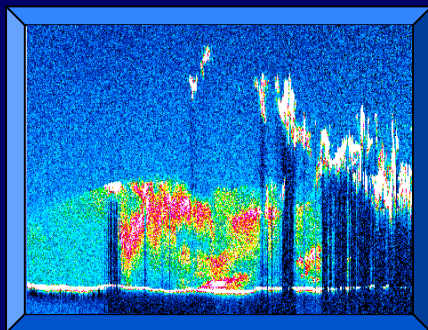
**Hyperspectral**



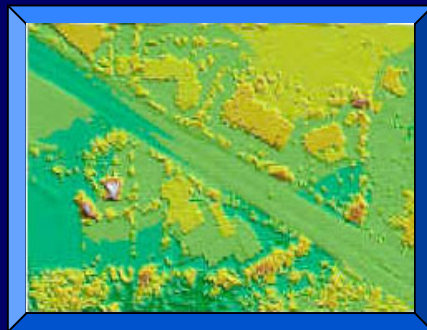
**RADAR / SAR**



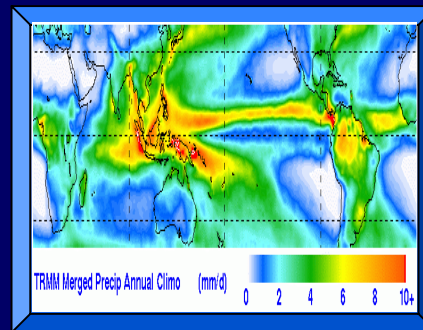
**Thermal**



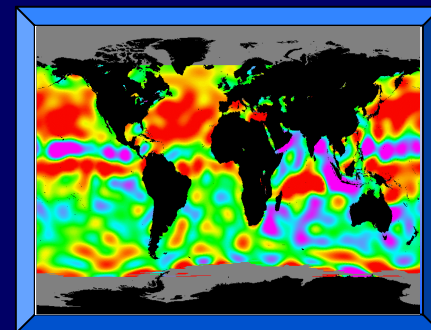
**Atmospheric LIDAR**



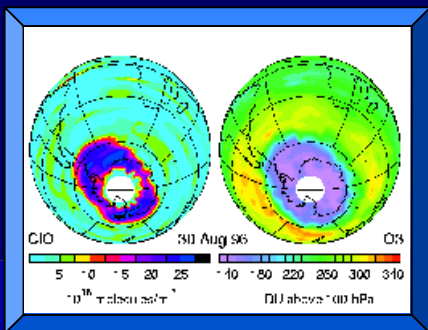
**Surface LIDAR**



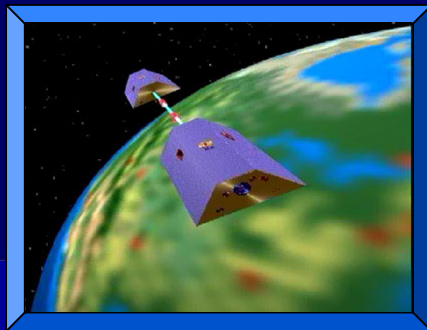
**Passive Microwave**



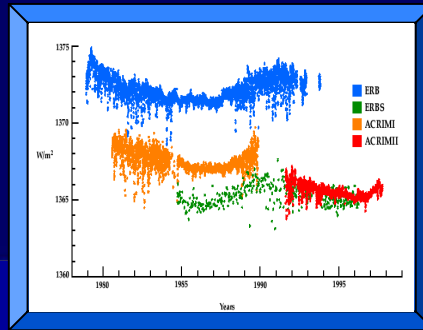
**RADAR Altimetry**



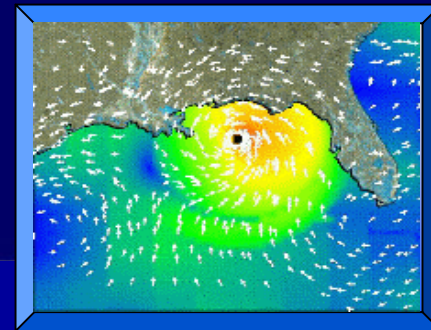
**Limb Sounding**



**Microwave Ranging**



**Irradiance/Photometry**

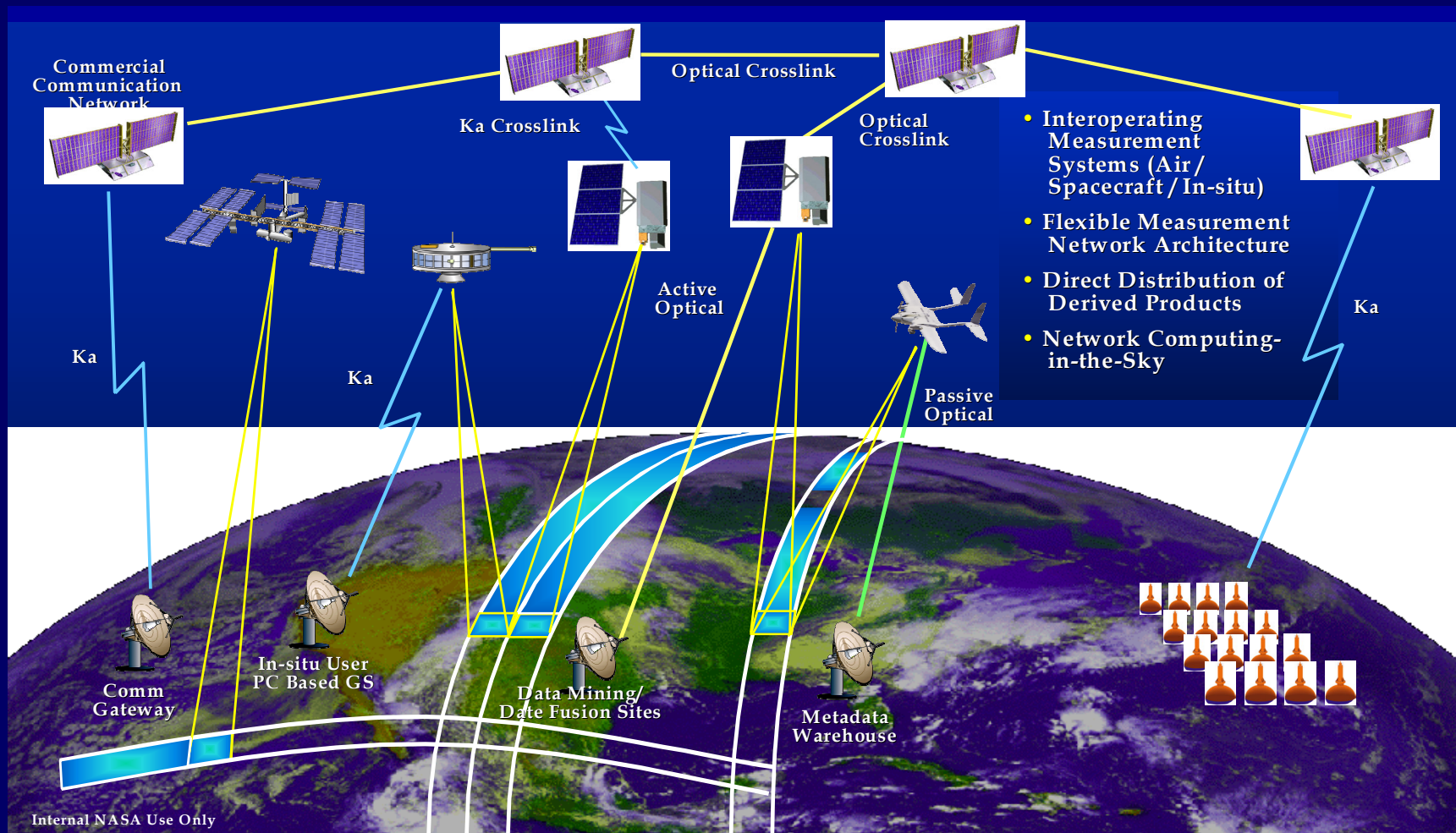


**Scatterometry**





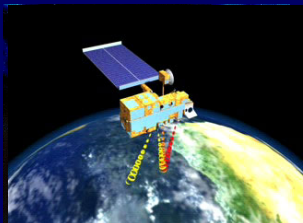
# Reconfigurable Communications Distributed Information-System-in-the-Sky





# ESE Measurement Missions

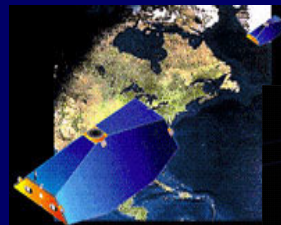
## Spaceborne Measurement Systems



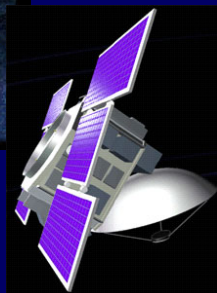
Terra



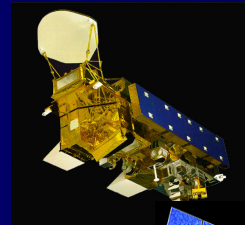
SeaWinds



GRACE



Cloudsat



Aqua



Jason-1



Aura



ICESat

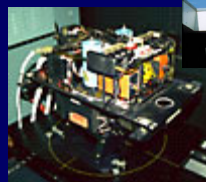
## Airborne & In Situ Measurement Systems



AVIRIS



MAMS



MASTER



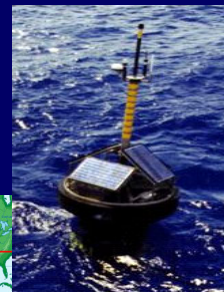
AERONET



Proteus



GTE/TRACE-P



MOBY



STARLink

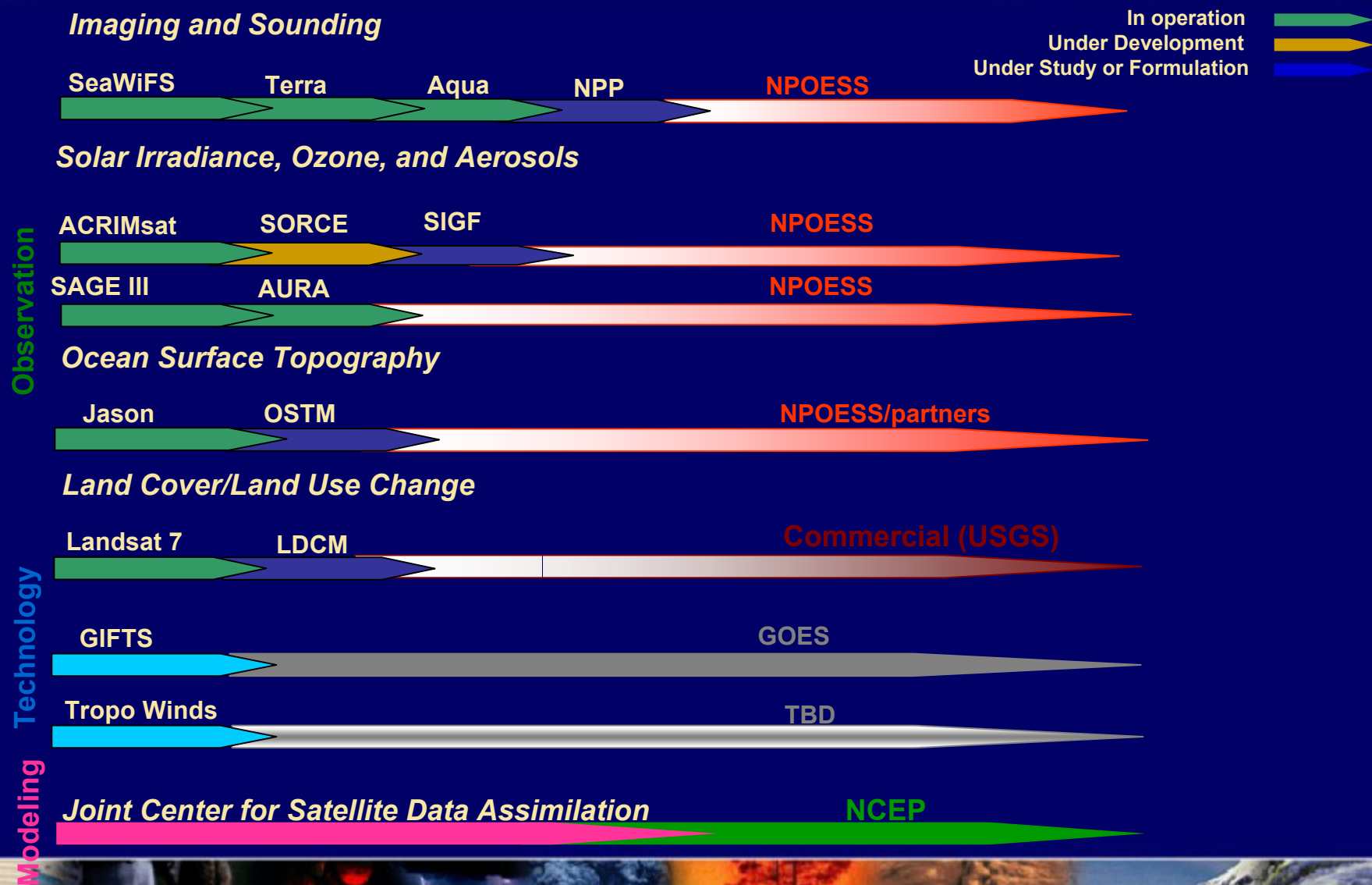


AOCI





# Transition from Research to Operations



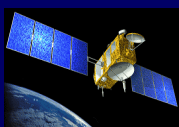
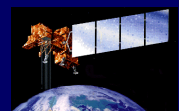
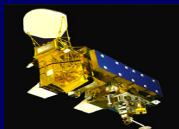




# Systematic Measurement Missions

## Existing

- Terra, Aqua
- Landsat 7
- TOPEX, Jason
- TRMM
- SeaWinds
- TOMS, OMI
- ACRIMSat/SORCE



## Through 2010

- NPOESS Preparatory Project (2005/06)
- LandSat Data Continuity Mission (2005/06)
- Ocean Topography Mission (2006)
- Global Precipitation Mission (2008)
- Ocean Surface Winds (2006)
- Total Column Ozone/Aerosols (2008)
- Solar Irradiance (2006)

- *Funded*
- *Under study/ early formulation*
- *Contained within NASA budget projections/undergoing preliminary study*



# National Applications: Approach

## Applications Research

- Extend scientific findings to requirements of operational environments
- Identify designs for information and data products -- particularly to enable use by automated systems

## Verification and Validation

- Evaluate and verify results of technology & operational technique
- Identify improvements for information products

## Applications Benchmark & Deployment

- Document prototypes, guidelines, and procedures for potential operational implementation

*The desired outcome of applications projects is for the partner organization to use the resulting prototypes, processes, and documentation as benchmarks for operational use*







# *National Applications*



**Carbon  
Management**



**Public Health**



**Energy Forecasting**



**Aviation Safety**



**Water  
Management**



**Homeland  
Security**



**Coastal  
Management**



**Disaster  
Preparedness**



**Agricultural  
Competitiveness**



**Invasive Species**



**Community Growth**



**Air Quality**





# *Environmental Indicators for Coastal Management*







# ***Coastal: HAB Forecasts***

## **NOAA HAB Forecast System:**

- Identify occurrence of HABs
- Track the transport
- Predict severity and landfall
- Forecast demise

## **Forecasts can support local managers:**

- Close beaches
- Adjust harvest quotas
- Protect aquaculture
- Plan mitigation strategies

System depends on biological, chemical and physical processes underlying the blooms and oceanography.





# *Coastal: HAB Partners*

## **Primary: NOAA**

- National Ocean Service (NOS)
- NOS Coastal Services Center

*NOAA operates the HAB Forecast System*

## **Additional Partners:**

- EPA & Gulf of Mexico Lab
- ONR
- HAB Community







# Coastal Management Decision Support

## MODELS

Ocean Circulation  
Wind Patterns/Circulation  
Chlorophyll a  
Others

**Data**

## MEASUREMENTS

Aqua  
Terra  
Jason-1  
SeaWiFS  
Topex/Poseidon  
QuikSCAT  
SeaWinds  
TRMM  
NPP  
POES, GOES (NPOESS)

Information Products,  
Predictions, and Data  
from NASA ESE  
Missions and Models:

- Speed and direction of ocean currents
- Nearshore upwelling
- Sea surface heights
- Sea surface temperature
- Surface winds
- Precipitation/Rain rates
- Salinity predictions
- Phytoplankton concentrations

## DECISION SUPPORT

HAB/Hypoxia Forecasts

### **Analysis:**

- Predict landfall
- Track transport, speed and direction
- Assess severity
- Predict initiation
- Forecast duration/demise

### **Management Decisions:**

- HAB warnings
- Beach closures
- Shellfish quotas
- Finfish limits
- Aquaculture flushing and recirculating
- Mitigation response

### **Additional factors:**

- Notices where blooms not expected to occur
- Minimize extent of false positives and false negatives

## VALUE & BENEFITS

- Improve public health
- Reduce hospital admissions from toxin exposure
- Reduce lost workdays and schooldays
- Improve siting and design of aquaculture facilities
- Efficient shellfish harvest quotas before HAB events
- Increase confidence in government
- Minimize impacts to recreational fishing and tourism
- Pro-active outreach to reduce impacts to regional economies



# NOAA / NASA Agreement

## *Proposed Agreement between NASA Applications Program and NOAA Coastal Services Center*

- Coastal Decision Support
  - Verify, validate, and benchmark remote sensing systems and information products for use in operational coastal systems
- Development of Coastal NSDI
  - Evaluate relevance of remote sensing systems & data of priority resource community
- Coastal Flooding Tools
- Next Generation Requirements
- Performance Measures







# Applications Roadmap: Coastal Management Harmful Algal Blooms (HAB) & Hypoxia

**DRAFT**

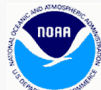
HAB/Hypoxia Forecasts (c. 2012)



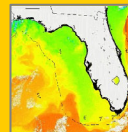
- X-Y day warning
- X% initiation
- Y% landfall +/- X km
- X% dissipation



## Primary Partners:



- Day/night S.S.Temp
- 3-D coastal circulation models incorporating biological data



**Outcomes:** 3-4 day warning of landfall. Routine detection. False negatives less than X%.

**Impacts:** Raise quotas for shellfish harvesting prior to HAB onset.

- Sea surface winds\*
- HAB/phytoplankton speciation



**Outcomes:** Routine identification of particular HAB species. Improved estimates of toxin severity 2-3 day landfall warning.

**Impacts:** Improve design and location of aquaculture facilities.

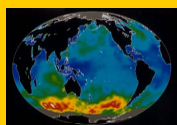
- Bio-optical sensors
- Improved coastal circulation models



**Outcomes:** Predictions of HAB transport, direction, and demise along coasts. Improved estimates of landfall area

**Impacts:** Warnings to fisheries and aquaculture facilities. Reduce impacts to non-target areas.

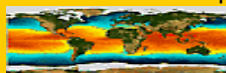
- Improved 2-D ocean circulation models
- Rain rates & salinity
- Sea surface height



**Outcomes:** 1-2 day warning of general landfall. Improved estimates of HAB demise. Warnings to close beaches.

**Impacts:** Reduce public exposure to toxins. Reduce hospital admissions and lost work/school days.

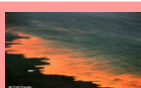
- Ocean color for chlorophyll a
- Sea surface temperatures



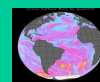
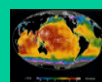
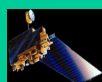
**Outcomes:** 0-1 day warning of landfall. Better understanding of HAB speciation. Improved estimates of initiation.

**Impacts:** Reduce economic impacts as possible. Build public confidence in forecasting systems.

HAB/Hypoxia Forecasts (c. 2002)



**Current trajectory:**  
Steady improvement in circulation models, HAB transport, and warning times.



2000

2002

2004

2006

2008

2010

2012

\* Pre-formulation

Socioeconomic Impact

Improved capabilities to decision support systems to forecast HAB initiation, transport, toxic severity, landfall and demise.



# *Louisiana project*

## *Louisiana Coast 2050 project, Sen. Breaux's Bill*

**Partner:** U.S. Army, Corps of Engineers, SAA signed June 2002, runs for 3 years.

**Objective:** How does NASA ESE digital data improve the cost and effectiveness of the Cultural Resources Management Assessment process.

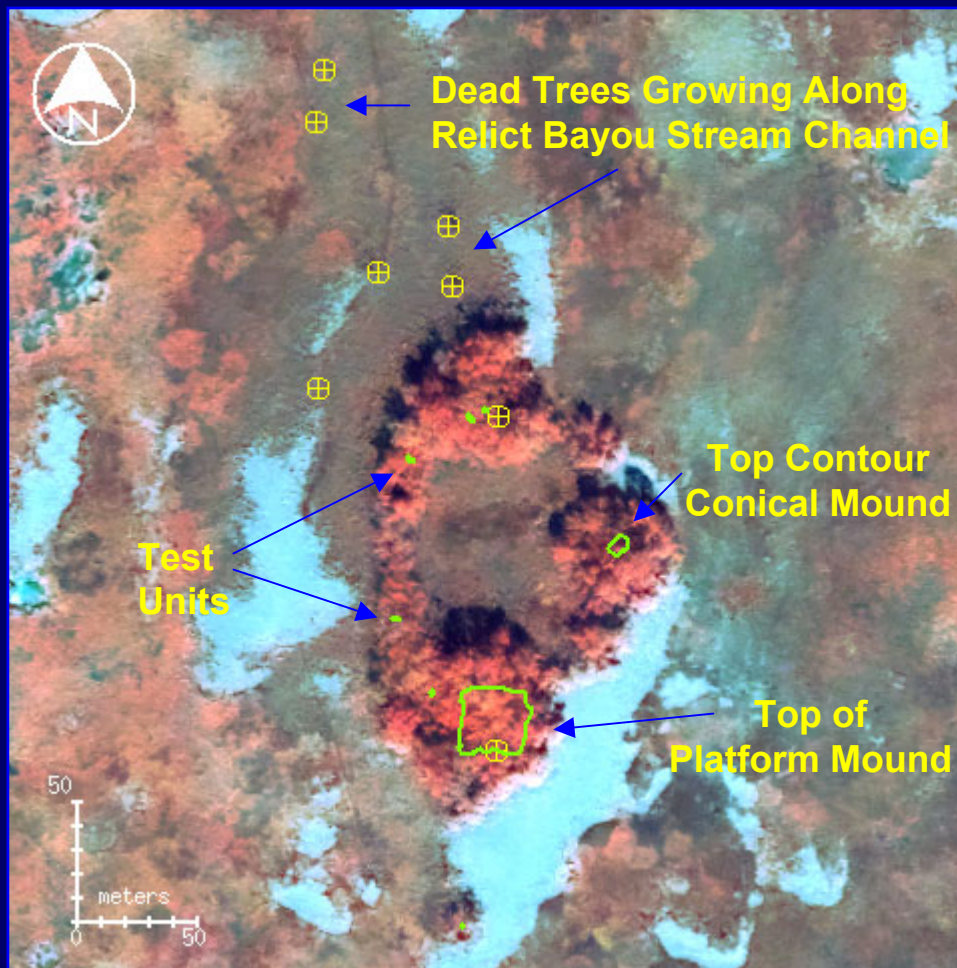
- NASA will collect and validate data, including degrading high resolution spatial and spectral data to ESE asset attributes.
- NASA will develop V&V process for subsistence, occupation and subsidence models
- COE will task contractors to conduct V&V in Coast 2050 project areas.
- COE will quantitative baseline and benchmark for ESE data product implementation.





# Louisiana project

GPS Survey Data for Pelican Mounds  
Overlay onto IKONOS Imagery



Photograph of Pelican Mounds  
Looking East







# Conclusions

- NASA has a well-articulated, end-to-end strategy to answer Earth science questions of substantial societal importance
- Transition of research observations and models while assuring “climate quality” to operational entities is critical element of NASA’s long-term strategy
- Our mutual challenge and opportunity is to transform remote sensing observations into earth science products that serve society’s needs

